41

UNITED STATES DISTRICT COURT EASTERN
DISTRICT OF MICHIGAN

MICHAEL J. HOUSE,

Plaintiff(s), Civil No. vs.

CASE NO. 2:19-cv-10586

JUDGE GERSHWIN A. DRAIN

MAGISTRATE JUDGE
STEPHANIE DAWKINS DAVIS

GENERAL ELECTRIC CO., ET AL.

LAWERENCE CULP, ET AL.,

Defendant(s).

FILED USDC - CLRK DET
2019 AUG 9 PM2:11

PLAINTIFF RESPONSE FOR DEFENDANT GENERAL ELECTRIC CO.'S

RULE 12(B)(3), (5), AND (6) MOTION TO DISMISS FOR

IMPROPER VENUE,_ INSUFFICIENT SERVICE OF PROCESS,AND

FAILURE TO STATE A CLAIM UPON WHICH RELIEF MAY BE GRANTED

1.PLANTIFF WILL DISMISS/WITHDRAW THE CLAIMS AGAINST

LAWRENCE CULP CEO ONLY.

2.VENUE GENERAL ELECTRIC THEY WERE PROPERLY SERVED

BECAUSE THEY ARE HERE IN COURT DEFENDING IT.

UNDER 28 USC 140.B VENUE IS PROPER BECAUSE,1 GE HAS A REGULAR AND ESTABLISHED PLACE OF BUSINESS IN EASTERN MICHIGAN EXHIBIT A, 1-3 ADDRESS 40 WEST E MAIN ST, VAN BUREN CHARTER TOWNSHIP,MI. 48111, AS WELL AS WESTERN MICHIGAN EXHIBIT B,1-2 ADDRESS 6120 NORTON CENTER DRIVE, MUSKEGON,MICHIGAN. 49441.

INFRINGEMENT OF PATENT PROCESS, PATENT US 7,140,873 B1 IS BEING INFRINGED UPON DAILY AT DETROIT METROPOLITAN WAYNE COUNTY AIRPORT DTW IN ROMULUS, MICHIGAN, 48242, WHERE AIRPLANES WITH THESE GE ENGINES, LIKE THE 747-B AND SIMILAR AIRCRAFT, ARE FLOWN AND OPERATED, MAINTAINED AND SERVICED WITH GE PARTS AS WELL AS REPLACED IF NEED BE.

3.PLAINTIFF ACKNOWLEDGES THAT HE SENT THE COMPLAINT AND SUMMONS BY CERTIFIED MAIL TO GE IN MASSACHUSETTS. IT IS UNDISPUTED THAT GE HAS THE ACTUAL NOTICE OF PLAINTIFF'S COMPLAINT. UNDER RULE 4(M), THE COURT SHOULD ORDER THE PLAINTIFF TO COMPLETE SERVICE WITHIN 14 DAYS, EITHER BY SERVING IT TO DEFENSE COUNSEL OR GE'S MICHIGAN RESIDENT AGENT EXHIBIT C, 1 OF 1 ADDRESS, 40600 ANN ARBOR RD E STE 201 PLYMOUTH MICHIGAN. 48170.

4. AMEND COMPLAINT. INSTEAD OF DISMISSING CASE, COURT SHOULD ALLOW PLAINTIFF TO FILE AMENDED COMPLAINT SETTING MORE DETAILED ALLEGATIONS OF INFRINGEMENT. ATTACHED ARE EXHIBITS TO THIS RESPONSE; EXHIBIT D, 1-4, SHOWS US PATENT 7,140,873 B1. EXHIBIT D, PART 1 OF 4 EXPLAINS THE ABSTRACT OF

THE MULTI ALL FUEL PROCESSOR SYSTEM AND METHOD OF PRETREATMENT FOR ALL COMBUSTION DEVICES. IT STATES A PROCESSOR SYSTEM AND METHOD FOR PRE TREATING ALL FUEL PRIOR TO COMBUSTION OF ANY COMBUSTION DEVICE AND CONTAINED IN A HIGH PRESSURE CHAMBER AND SUPERHEATED TO A STATE OF ELEVATED TEMPERATURE AND PRESSURE. THIS PROCESS WILL ALLOW ALL FUELS TO BURN MORE CLEANLY AND EFFICIENTLY AND WILL PROMOTE OPTIMUM COMBUSTION. EXHIBIT D, PART 2 OF 4, BACKGROUND OF INVENTION STATES THIS PROCESS TO ELIMINATE POLLUTION OF LAND, AIR AND WATER AND PRESERVE ENERGY. EXHIBIT D PART 3 OF 4, SHOWS THIS INVENTION PROCESS IS USED FOR ALL FUELS, LIQUID, GASEOUS,SOLIDS, NATURAL AS WELL AS MAN MADE. EXHIBIT D 4 OF 4 SHOWS THE ACTUAL PATENT CLAIMS 1, ABCD 2, 3, 4, 5, 6, 7 ALL ELEMENTS OF THESE CLAIMS ARE BEING INFRINGED UPON BY INCREASING THE PRESSURES AND INCREASING TEMPERATURES OF THESE JET ENGINES TO ACCOMPLISH GREATER EFFICIENCIES OF THESE JET ENGINES. THESE ACTIONS WERE STEADILY INCREASED SINCE THE PLAINTIFF INVENTOR MICHAEL J HOUSE

GAVE LETTERS OF SUBMISSIONS TO GENERAL ELECTRIC, DATED SEPTEMBER, 4,1998, VIA CERTIFIED MAIL. ATTACHED ARE THE INVENTION SUBMISSION TO GE WITH THE PATENT PENDING, ALSO KNOWN AS PROVISIONAL PATENT NUMBER 60/ 083,100. INCLUDED IN THE LETTER OF SUBMISSION WAS AN OFFER FROM MICHAEL J HOUSE TO A LICENSING AGREEMENT. THIS INFORMATION WAS USED BY GE TO INFRINGE UPON THIS PATENTED INVENTION. LISTED EXHIBIT E, 1-7 SHOWING ACCEPTANCE AND ACTUAL SUBMISSION LETTER TO GE AS WELL AS DOCUMENTED CERTIFIED RECEIPTS FROM THE US POST OFFICE.

EXHIBIT F, 1-3 PART 3 OF 3 SHOWS, IN WRITING, THAT GE ENGINEER TED INGLING ADMITS DEVELOPING THE WORLD'S

LARGEST JET ENGINES BY INCREASING THE PRESSURE RATIO INSIDE THE ENGINE AND ALSO RAISING THE TEMPERATURE. TO ACCOMPLISH THIS, THEY HAD TO DEVELOP MATERIALS THAT WERE ABLE TO WITHSTAND THE INCREASED TEMPERATURES AND PRESSURES INSIDE THE CORE OF THESE ENGINES. THE USE OF SUCH MATERIALS ARE DISCUSSED IN THE PATENT, SHOWING PATENT INFRINGEMENT OF ALL 7 CLAIMS OF US PATENT 7,140,873 B1

PLAINTIFF CAN PLEAD A SPECIFIC AND PLAUSIBLE CLAIM OF DIRECT INFRINGEMENT AGAINST GE OR IN THE ALTERNATIVE CAN PLEAD A SPECIFIC CLAIM OF INDUCED INFRINGEMENT, THEREFORE, INSTEAD OF DISMISSING THE CASE FOR FAILURE TO STATE A CLAIM, THIS AMENDED COMPLAINT SHOULD DO THAT.

EXHIBITS G 1-7, EXHIBITS H 1-7 AND EXHIBITS I 1-2 SHOW THAT GE HAS STEADILY INCREASED THE TEMPERATURES AND PRESSURES INHERENTLY IN THESE JET ENGINES. AS TO THE CLAIMS OF THIS INVENTION PROCESS, USING THESE CLAIMS AS PERMANENT AND INSEPARABLE ELEMENTS OF THESE ENGINES, THESE CLAIMS ATTRIBUTE TO THESE GENERAL ELECTRIC JET ENGINES FOR GREATER EFFICIENCY AND PERFORMANCE.

MICHAEL J HOUSE Signature of Filer

Date 8/8/2019

Printed Name : MICHAEL J. HOUSE

Street Address 27855 CALIFORNIA DR NW

City, State, Zip CODE, LATHRUP VILLAGE
MICHIGAN 48076

Telephone Number 248-979-0332

EXHIBIT A, Part 1 of 3

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EXHIBIT A, Part 2 of 3

Granholm Lauds GE's Decision to Locate New Advanced Technology and Training Center in Michigan

Contact: Bridget Beckman 517-335-4590

June 26, 2009

New advanced manufacturing/software technology center in Van Buren Twp.expected to create 1,200 high-tech jobs

LANSING - Governor Jennifer M. Granholm today announced that General Electric Company (NYSE: GE) has chosen Michigan for a new advanced technology and training center to be located at Visteon Village in Van Buren Twp. (Wayne County). The company plans to make a significant financial investment in the new center that is expected to create 1,200 direct jobs and more than 1,600 indirect and spin-off jobs, according to an economic analysis conducted by the Michigan Economic Development Corporation (MEDC).

Joining the governor in today's announcement was GE Chairman and CEO Jeff Immelt, U.S. Senators Carl Levin and Debbie Stabenow, President Obama's Director of Recovery for Auto Communities and Workers Ed Montgomery, Wayne County Executive Robert Ficano, Lt. Governor John D. Cherry, Jr., and other state and local officials.

"No state is working harder than Michigan to diversify its economy and create new jobs," Granholm said. "GE's decision to invest and grow in Michigan demonstrates that we have the high-tech workforce and competitive business climate necessary for global giants like GE to thrive in the 21st century."

The center will focus on the development of advanced manufacturing technology and software and information technology and will consolidate GE's experts in software development, data architecture, networking, business intelligence and program management. They will develop software to support GE's business operations for several advanced technologies. The site also will serve as a training hub for GE information technology professionals.

"To lead in manufacturing, grow our exports and create high-value jobs in the U.S., we must invest in technology and in people," GE Chairman and CEO Jeff Immelt said. "The scientists, engineers and technologists that will work and learn at this center will help GE develop innovative new software, processes and technologies to make our manufacturing businesses even more productive and competitive. Michigan is a great location for a technology center because of its world-class engineering, technical talent and public officials who understand that investing now will create tomorrow's leading positions in information technology, clean energy and transportation."

GE also will establish a research and development center at the site that will be

EXIBIT A, Part 3 of 3

part of GE's Global Research network. It will house scientists and engineers who will develop next generation manufacturing technologies for GE's leading aircraft engines, gas turbines, renewable energy and other high technology products. Such work will include development of composites, machining, inspection, casting and coating technologies for GE's Aviation and Energy businesses.

"With operations throughout the world, GE could have located this project in any number of states or countries," MEDC President and CEO Greg Main said. "The decision to invest and grow in Michigan puts us in a very elite class of business locations that can attract this kind of high-tech project."

Based on the MEDC's recommendation, the Michigan Economic Growth Authority (MEGA) board today approved a state tax credit valued at $73.9 million over 12 years to help win the project over competing sites in other states. Wayne County and Van Buren Township worked closely with the MEDC to win GE's investment, and both have committed to support the project.

The center is expected to open later this year. Software and IT staff will be located in existing office space at the site. GE expects to construct a 100,000-square-foot research center on the site to house its research and development activities.

About GE

GE (NYSE: GE) is a diversified global infrastructure, finance and media company that is built to meet essential world needs. From energy, water, transportation and health to access to money and information, GE serves customers in more than 100 countries and employs more than 300,000 people worldwide. GE is Imagination at Work. For more information, visit the company's Web site at http://www.ge.com.

About GE Global Research

GE Global Research is one of the world's most diversified industrial research labs, providing innovative technology for all GE's businesses. Global Research has been the cornerstone of GE technology for more than 100 years, developing breakthrough innovations in areas such as medical imaging, energy generation technology, jet engines and lighting. GE Global Research is headquartered in Niskayuna, New York, and has facilities in Bangalore, India, Shanghai, China, and Munich, Germany. Visit GE Global Research at www.ge.com/research.

About MEDC

MEDC, a partnership between the state and local communities, promotes smart economic growth by developing strategies and providing services to create and retain good jobs and a high quality of life. For more information on the MEDC's initiatives and programs, visit www.TheMEDC.org.

# # #

EXHIBIT B, Part 1 of 2

GE Aviation Opens New Brilliant Factory

Muskegon, MI | May 1, 2017 - GE Aviation celebrated in Muskegon today the grand opening of its $14.5 million Brilliant Factory - an investment that will stimulate economic growth in the region and where GE is using data and analytics to run its plants more efficiently.

For the event, John Bowman, general manager, Supply Chain for GE Aviation joined Senator Debbie Stabenow, State Senator Goeff Hansen, State Representatives Terry Sabo and Holly Hughes, the Honorable Gary Nelund, Mayor of Norton Shores, The Honorable Steve Gawron, Mayor of Muskegon, Jennifer Nelson, executive vice president Business Development for the Michigan Economic Development Corporation and local officials.

"The new facility in Muskegon is the first of several GE Brilliant Factories being built throughout the world where machine downtime has been reduced to less than 1%," said John Bowman.

The new 35,000-square-foot facility will manufacture parts for the GE90 engine and will perform development work for new programs as needed. The GE90 on the Boeing 777 is the world's most powerful jet engine with about 2,500 engines in service and more than 67 million flight hours.

"This state-of-the-art GE Aviation facility is creating new advanced manufacturing jobs and supporting our local economy," said Senator Stabenow. "It's exciting to see Muskegon County and Norton Shores leading the way in making components for GE's most powerful jet engine."

"GE's brilliant factories combine the newest technologies, from advanced analytics to 3D printing to collaborative robots that work side-by-side with people," added Bowman. "The facility represents an investment in advanced manufacturing -- our workforce is constantly adapting and updating their skills for the jobs of tomorrow."

The new facility located at 6120 Norton Center Drive, Muskegon, expands GE Aviation's foot print in Muskegon to about 220,000 square feet total including three buildings (the new facility in Norton Shores, along with existing manufacturing in Norton Shores and Muskegon).

"We are proud of our association with GE Aviation and the GE Aviation-Muskegon team," said Jen Nelson, executive vice president, Michigan Economic Development Corporation. "We are also quite proud of helping to foster an environment that supports growth in the aerospace field, putting us among the most attractive and competitive aerospace manufacturing states in the nation. GE Aviation's significant investment and job-creation commitment are encouraging signs of the future economic success of Muskegon and the state of Michigan."

GE has already hired nearly 90 new employees toward a goal of 100 at this advanced manufacturing facility, bringing the total to almost 800 employees

EXHIBIT, B, Part 2 of 2

across the three buildings.

Bowman continued, "Muskegon is leading the way for GE's transformation in the way we use big data to run our plants more efficiently and effectively." The idea behind the Brilliant Factory is to link design, engineering, manufacturing, supply chain, distribution and services into one intelligent system. The system collects and analyzes data from all these disciplines to make factories smarter, combining things like sensor enablement, digital design, and factory and supply chain optimization to improve quality, throughput and yield.

By equipping machines with sensors and analyzing the data in real time, GE can determine when a machine might break well before it fails. Sensor-enabled manufacturing lines feed data to GE's cloud-based Predix platform. This has helped reduce unplanned downtime on the shop floor by up to 20 percent and has improved overall product reliability and cost. In addition to advanced processes and tools, there is also a digital thread running through the factory, both horizontally across the company and vertically throughout the value chain, which provides an integrated view of a product throughout the manufacturing lifecycle. Watch a video on GE's brilliant factories here.

GE announced plans to expand in Muskegon in 2016. The Michigan Economic Development Corporation encouraged this expansion by providing a grant to GE for $800,000. The City of Norton Shores also provided a 50% property tax abatement to GE for a 12-year period.

GE is the world's Digital Industrial Company, transforming industry with software-defined machines and solutions that are connected, responsive and predictive. GE is organized around a global exchange of knowledge, the "GE Store," where each business shares and accesses the same technology, markets, structure and intellect. Each invention further fuels innovation and application across our industrial sectors. With people, services, technology and scale, GE delivers better outcomes for customers by speaking the language of industry.

EXHIBIT C

Summons to Residence Michigan Agent

LARA Corporations Online Filing System
Department of Licensing and Regulatory Affairs

ID Number: 801013556 Request certificate New search

Summary for: GENERAL ELECTRIC COMPANY

The name of the FOREIGN PROFIT CORPORATION: GENERAL ELECTRIC COMPANY

Entity type: FOREIGN PROFIT CORPORATION

Identification Number: 801013556 **Old ID Number:** 632516

Date of Qualification in Michigan: 12/24/1917

Incorporated under the laws of: the state of New York

Purpose:

Term: Perpetual

Most Recent Annual Report: 2018 **Most Recent Annual Report with Officers & Directors:** 2018

The name and address of the Resident Agent:

Resident Agent Name:	THE CORPORATION COMPANY				
Street Address:	40600 ANN ARBOR RD E STE 201				
Apt/Suite/Other:					
City:	PLYMOUTH	State:	MI	Zip Code:	48170

Registered Office Mailing address:

P.O. Box or Street Address:					
Apt/Suite/Other:					
City:		State:		Zip Code:	

The Officers and Directors of the Corporation:

Title	Name	Address
PRESIDENT	JOHN L FLANNERY	41 FARNSWORTH STREET BOSTON, MA 02210 USA
TREASURER	DANIEL C JANKI	901 MAIN AVENUE NORWALK, CT 06851 USA
SECRETARY	MICHAEL HOLSTON	41 FARNSWORTH STREET BOSTON, MA 02210 USA
DIRECTOR	JOHN J BRENNAN	100 VANGUARD BLVD MALVERN, PA 19355 USA
DIRECTOR	EDWARD P GARDEN	280 PARK AVE NEW YORK, NY 10017 USA
DIRECTOR	RISA LAVIZZO-MOUREY	1301 BLOCKLEY HALL 423 GUARDIAN DRIVE PHILADELPHIA, PA 19104 USA
DIRECTOR	JAMES J MULVA	600 NORTH DAIRY ASHFORD HOUSTON, TX 77079 USA
DIRECTOR	THOMAS W HORTON	1717 MCKINNEY AVENUE, SUITE 1610 DALLAS, TX 75202 USA
DIRECTOR	SEBASTIAN M BAZIN	82 RUE HENRI FARMAN, CS 20077 LSSY-LES-MOULINEAUX, 92445 FRA
DIRECTOR	JOHN L FLANNERY	41 FARNSWORTH STREET BOSTON, MA 02210 USA
DIRECTOR	FRANCISCO D'SOUZA	500 FRANK W BURR BLVD TEANECK, NJ 07666 USA
DIRECTOR	W GEOFFREY BEATTIE	17 PRINCE ARTHUR AVE, 3RD FLOOR TORONTO, ON M5R1B2 CAN

US007140873B1

EXHIBIT D, Part 1 of 4

(12) **United States Patent**
House

(10) **Patent No.: US 7,140,873 B1**
(45) **Date of Patent: Nov. 28, 2006**

(54) **MULTI ALL FUEL PROCESSOR SYSTEM AND METHOD OF PRETREATMENT FOR ALL COMBUSTION DEVICES**

(75) Inventor: **Michael J. House**, 16181 Softwater Lk. Dr., Linden, MI (US) 48451

(73) Assignee: **Michael J. House**, Linden, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/259,593**

(22) Filed: **Mar. 1, 1999**

(51) **Int. Cl.**
F23N 1/02 (2006.01)

(52) **U.S. Cl.** **431/11**; 431/41; 219/628; 123/557

(58) **Field of Classification Search** 431/208, 431/11, 12, 41, 36; 219/628, 629, 635, 202, 219/205; 123/557, 558, 549
See application file for complete search history.

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Primary Examiner—S. Gravini

(57) **ABSTRACT**

A processor system and method for pretreating ALL FUELS prior to combustion of a any combustion device such as an engine in which fuel in a liquid state is contained in a high pressure chamber and superheated to a state of elevated temperature and pressure.super heated fuel is then injected into the combustion chamber for burning as demanded by the combustion device. This process holds true for ALL FUELS. Liquids, Gaseous, Pulverized Solids and Solids. Making it an Ideal UNIVERSAL self contained process that can be adapted to existing needs as well as new needs for total energy use. This Process will allow ALL FUELS to burn more cleanly and efficiently and will promote optimum combustion.

7 Claims, 1 Drawing Sheet

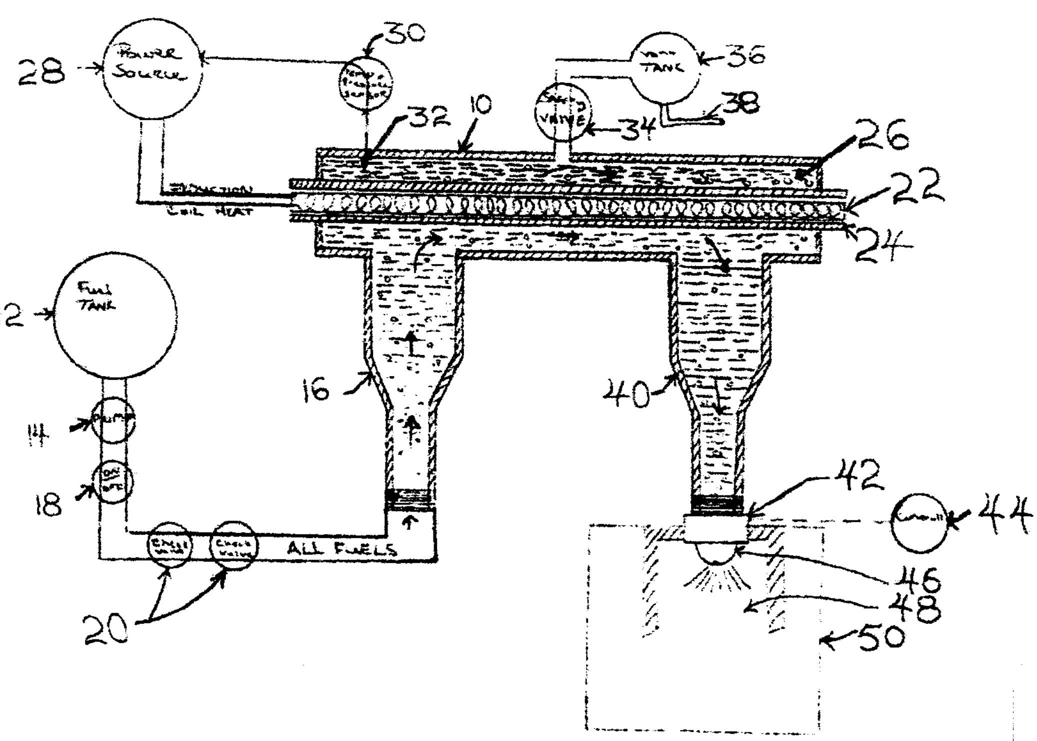

EXHIBIT D, Part 2 of 4

MULTI ALL FUEL PROCESSOR SYSTEM AND METHOD OF PRETREATMENT FOR ALL COMBUSTION DEVICES

CROSS-REFERENCE TO RELATED APPLICATIONS

Not applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable

REFERENCE TO A MICROFICHE APPENDIX

Not applicable

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention concerns a new and useful process that involves the burning of any combustible fuels: liquid, gaseous, and solids; such as gasoline, diesel, kerosene, alcohol, natural gas, coal, medical waste, hazardous waste, and/or any fuel medium, to generate mechanical or heat energy. This new process is useful for any fuel, natural or man made, etc. Thus, it may increase the efficiency of all fuels, while reducing emissions of fuels being processed prior to combustion with this new process, thus to eliminate pollution of land, air, and water, and preserve energy.

2. Description of the Prior Art

The efficiency developed by combustion devices such as engines, boilers, or any device depends, to a large degree, on the completeness of combustion for any fuel. Emissions, also, will increase or decrease to a great extent to the degree when complete combustion occurs.

Accordingly, considerable efforts have been exerted towards improving the efficiency of gasoline fuel in engines and some other combustion devices, such as boilers. These other efforts seem to be very limited in their applications.

Through patent research, I cannot find an invention of this like. This invention, that I have created, is a very truly needed and a new and useful process. My invention is especially unique in the fact that this same new process is intended for all fuels. My claims are specific and clear cut, in that, this process is intended for use of all fuels: solid, liquid, and gaseous, which no other invention claims.

The present invention seeks to provide a new process in such a way as to further enhance combustion of all fuels, making this a truly universal new process that can be adapted to all combustion mediums, new and old.

BRIEF DESCRIPTION OF THE VIEW OF THE DRAWING

FIG. 1 is a plan view of the device used to carry out the invention process referred to as "Multi All Fuel Processor and Pre-treatment for all Combustion Devices"

DETAILED DESCRIPTION

In the following detailed description, certain technology will be employed for the sake of clarity and a particular embodiment described in accordance with the requirements of 35 USC 112, but to be understood that the same is not intended to be limiting, inasmuch as the invention is capable of taking many forms and variations within the scope of the appended claims.

Referring to the FIG. 1, the present invention involves a processing system for super preheating of any fuel prior to burning in a combustion chamber (**48**) or a combustion device (**50**).

The superheating is carried out in a heavy walled, high pressure, and high temperature tubular enclosure (**10**). Fuel from a storage tank (**12**) is directed, under pressure, to an inlet fitting (**16**) by operation of a pump (**14**), so as to maintain the high temperature and high pressure chamber (**26**), defined within the enclosure (**10**), filled with fuels that are liquids, gaseous, pulverized solids, and solids. Also provided, is a shut-off valve (**18**) and one or more check valves (**20**), able to withstand high temperature and high pressure on the order of several hundred degrees and pounds per square inch, or unlimited. The pump (**14**), also, must be capable of developing such pressures as to enable delivery of all fuels into chamber (**26**) against the high pressure developed therein, by superheating.

A tungsten porcelain electrical resistance induction heating element (**22**) extends lengthwise within a tubular heater chamber (**24**), defined within the enclosure (**10**). All fuels are directed into the annular chamber (**26**) surrounding the induction heating rod (**22**) to be heated, thereby, the heater power source (**28**), controlled by thermostatic controls (**30**) responsive to a temperature sensor (**32**) located in chamber (**24**).

The wattage of the electrical heater rod (**22**) should enable heating of: any fuel, as high as safely possible; liquid fuels, above their boiling point while under pressure; gaseous fuels, should stay below their auto-ignition point while under pressure; pulverized solids, will also have auto-ignition points to stay below to eliminate spontaneous combustion; and solid fuels. The rate corresponds to the flow demand required by the combustion devices (**50**) using the super preheating processor system.

A pressure relief valve (**34**) allows safety pressure relief to a vent holding tank (**36**), which can communicate with the fuel tank (**12**) via a return drain line (**38**). A shield, or insulating panels (not shown) may also optionally be provided as safety measures.

The processed, super heated, and pressurized fuel in annular chamber (**26**) passes out to an outlet fitting (**40**) communicating with an open/close injector valve (**42**), controls (**44**) determining the duration of the open interval for the demand required by the particular combustion devices. A controlled quantity of processed, super heated, and super pressurized, fuel is injected through a spray nozzle (**46**) into the combustion chamber (**48**) of those particular combustion devices (**50**).

It will be understood that details of the combustion devices (**50**) are not shown, as these may be conventional, but that suitable air and a good stoichiometric ratio, ignition, and fuel will ordinarily be included.

When working with fuels that require high temperatures and high pressures, the working stress of what materials used to manufacture this process should take a minimum ×10 to 15 percent of the ultimate strength for safety factors.

I have, through testing and development of different fuels, liquids, gaseous and solids, created a process that is universal and capable of processing all fuels because of the extreme temperatures the process requires; burning of hydrocarbons and omissions take place only at high temperatures.

EXHIBIT D, Part 3 of 4

In the testing and development of this process, I have developed principles to be followed, not only for safety factor reasons, but for optimum efficiencies of combustion for whatever fuel you chose to utilize with this process. Included in Appendix 1 of this package, shows a photograph of a test bench that I have created in order to safely open flame test all fuel prior to use in order to establish three physical states of matter: solids; liquids; and gaseous. Of these states, for whatever fuel you choose to use, limits will have to be established for operation, melting points, boiling points, cryogenic points, expansion ratios, flash points, flammable ranges, LEL (lower explosive limits), to lean UEL (upper explosive limits), to rich ignition temperatures how hot a particular fuel needs to run, auto-ignition temperatures for spontaneous combustion, vapor density, specific gravity, and/or any testing that will establish safe limits in which any fuel can be utilized. Also, the use of an instrument called a spectrometer can be used to test molecular structure, weight, formula, and analysis of all fuels prior to use, in establishing safe guide limits prior to use of any fuels.

Appendix 2 photographs that show an example of kerosene fuel in an open flame bench test were performed to establish these types of limits. Notice the photograph of open flame test that is very yellow in appearance. This fuel is an ambient temperature and is not clean. You can see the presence of free carbons, that cause pollution, by their bright yellow color. Now, the other photograph shows the invention process being tested with the same fuel, kerosene, by unlimitedly super heating this fuel. Only, the visual flame can be seen to burn much cleaner and efficiently because this invention process allows for complete combustion to occur, inhibiting free carbons, emissions, and pollutants, thereby increasing efficiencies.

Listed, are Methods for Processing the 3 Physical States of all Fuels:

All fuels will have boiling points and points that are listed on the previous paragraph above, that you need to know prior to processing of any fuel used: solids, liquids, and gaseous. These points will establish safe limits of processing for that particular fuel before use on any application.

Liquid Fuels:

Processing with high temperatures and pressures are very obtainable because the containment device can be made to withstand these internal and external forces, allowing the liquids to be kept under pressure proportional to temperature, and kept from boiling while super heated. Because of lack of oxygen in liquid fuels, the chance of auto-ignitions of spontaneous combustion is virtually eliminated. Frequently, combustion calculations can be simplified by using molecular mass (weight) as the basis for calculations, but calculating and bench testing should be used to establish guides for the particular fuel of use prior to production use of this process on any combustion mediums. If liquid oxygen is added to fuels, auto-ignition temperatures and pressures should be tested. All fuels should try to stride for unlimited temperatures and pressures in this process. Included in Appendix 3 of this package, are examples of some liquid fuels tested in atmospheric pressure, showing the approximate temperature certain fuels can produce. These temperatures can gain even higher through this process while increasing pressure for the optimum combustion of all fuels.

Gaseous Fuels

Processing with high temperature and pressures are very obtainable because the containment device can be made to withstand these internal forces created, but auto-ignition can occur if mixtures of gases or vapors with air or oxygen will explode spontaneously if the temperature is sufficiently high. Auto-ignition temperatures are markedly decreased as the pressure is raised above atmospheric. Minimum auto-ignition temperatures and pressures should be established with safety factors in mind prior to use of any fuel. All fuels should try to stride for unlimited temperatures and pressures in this process. Included in Appendix 4 of this package, are examples of minimum auto-ignition temperatures of fuels in air or oxygen at atmospheric pressures. These temperatures can gain even higher through this process while increasing pressure for the optimum combustion of all fuels.

Solid Fuels

Processing with high temperatures and pressures are very obtainable because the containment device used to carry out this process can be made to withstand these internal and external forces, allowing for ultimate efficiencies. Solid fuels are very similar in processing to those of liquid fuels.

Pulverized Solid Fuels

Processing with high temperature and high pressure are very obtainable because the containment device can be made to withstand these internal and external forces created, but auto-ignition can occur if mixture of gases or vapors with air or oxygen will explode spontaneously if the temperature is sufficiently high. Pulverized solid fuels are very similar in processing to that of gaseous fuels.

Appendix 11 shows physical and chemical properties of methane and gasoline. This process requires testing of whatever fuels you choose to process before processing use, so that safety standard can be established for that application.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS AND PHOTOGRAPHS

The file on this patent contains at least one drawing and photograph executed in color. These color drawings and color photographs are necessary to understand the working principles of this process, "Multi All Fuel Processor System and Method of Pre-treatment for Combustion Devices".

Listed, are Appendix, 1 through 12B:

Appendix 1: Test Bench created by inventor, Michael J House

Appendix 2: Test Bench burning Kerosene

Appendix 3: Liquid fuels tested, approximate temperatures fuels obtain

Appendix 4: Gaseous fuels auto-ignition temperatures

Appendix 5: Inventor, Michael J House, holding processor

Appendix 6: Inventor holding actual device used in process

Appendix 7: Color drawings, 7/28/96, to carry out process

Appendix 8: Color drawings, 4/26/93, to carry out process

Appendix 9: Color drawings, 12/17/88, to carry out process

Appendix 10: Color drawings, 12/17/88, to carry out process

Appendix 11: Physical and chemical properties for methane and gasoline

Appendix 12A: Actual invention process installed on an automobile engine test vehicle made by inventor, Michael J House

Appendix 12B: Actual test vehicle using invention process

EXHIBIT D, Part 4 OF 4

I claim:

1. A process for the pre-treatment of fuels prior to combustion within a multi-chambered combustion device, comprising the steps of:

a) super pre-heating a fuel within a main chamber of said multi-chambered combustion device utilizing an internal electrical resistance induction element, said element located in a chamber within said multi-chambered combustion device thereby shielded from direct contact with said fuel;

b) selectively increasing the pressure of said temperature-elevated fuel within said main chamber by controlling the flow of said fuel moving through said multi-chambered combustion device;

c) keeping said elevated temperature constant within said multi-chambered combustion device utilizing said electrical resistance induction element, so as to further maintain an elevated pressure of said fuel; and

d) transferring said temperature-elevated fuel into a combustion chamber, said combustion chamber utilizing an electrical discharge element for combustion, said combustion chamber in fluid communication with said main chamber of said multi-chambered combustion device.

2. The process of claim 1 wherein said fuel is selected from the group consisting of liquid fuel, gaseous fuel, solid fuel, and finely pulverized solid fuel.

3. The process of claim 1 wherein said super pre-heating step (a) is carried out in a metal alloy enclosure cable of withstanding a high pressure and a high temperature.

4. The process of claim 1 wherein said selectively increasing the pressure step (b), further comprises the steps of:

a) withdrawing said fuel from a storage vessel; and

b) directing said fuel utilizing a pump through an inlet fitting on said multi-chambered combustion device.

5. The process of claim 1 wherein said keeping said elevated temperature constant step (c) is aided by a multitude of check valves on said multi-chambered combustion device.

6. The process of claim 1 wherein said transferring step (d) is achieved by a pump capable of performance at a high pressure and a high temperature.

7. The process of claim 1 wherein a tungsten porcelain electrical resistance induction heating element is responsible for said super pre-heating of said fuel.

* * * * *

EXHIBIT E-Part, 1 of 7

EXHIBIT E-Part, 2 of 7

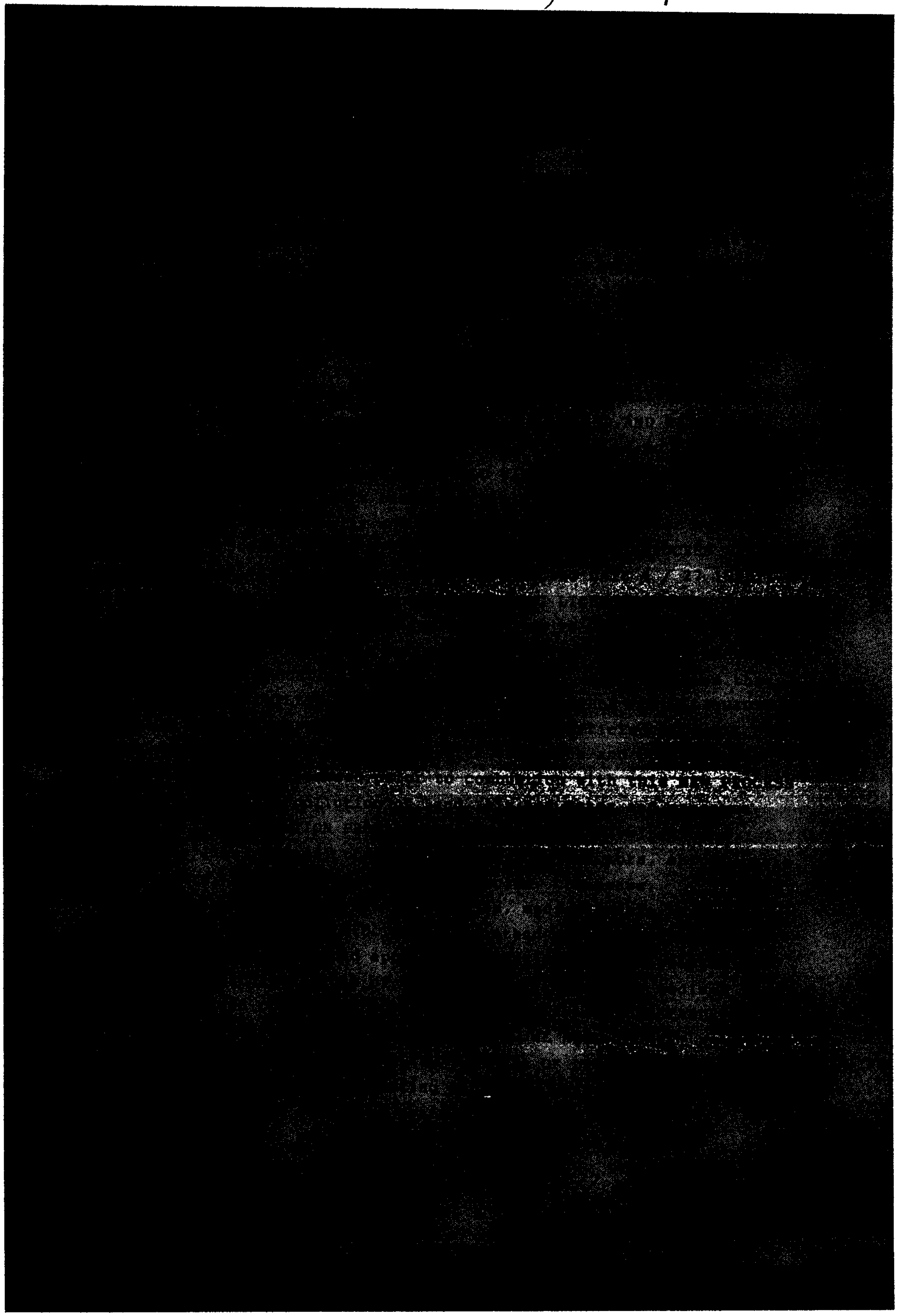

EXHIBIT E - PART 3 of 7

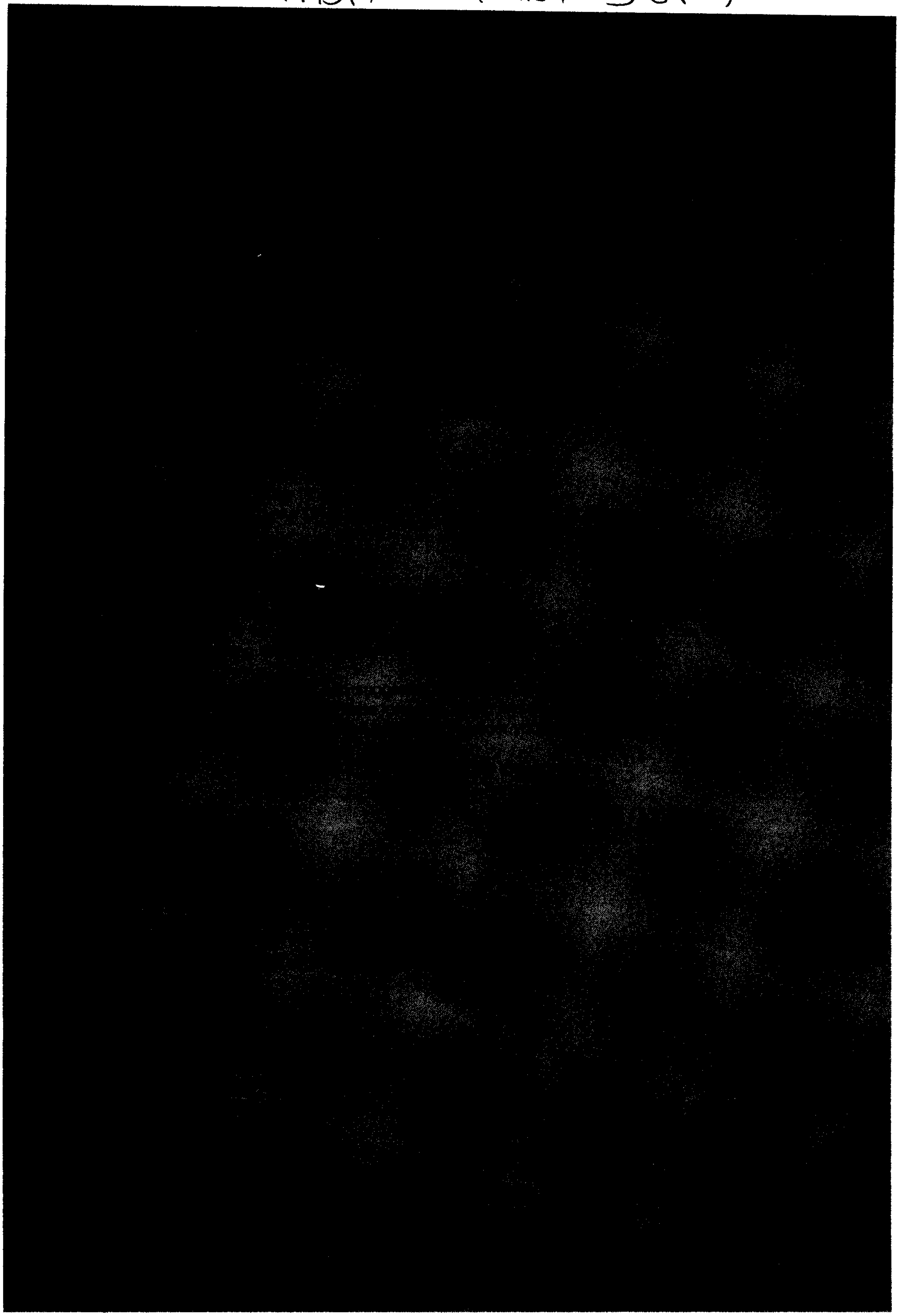

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EXHIBIT E - Part 4 of 7

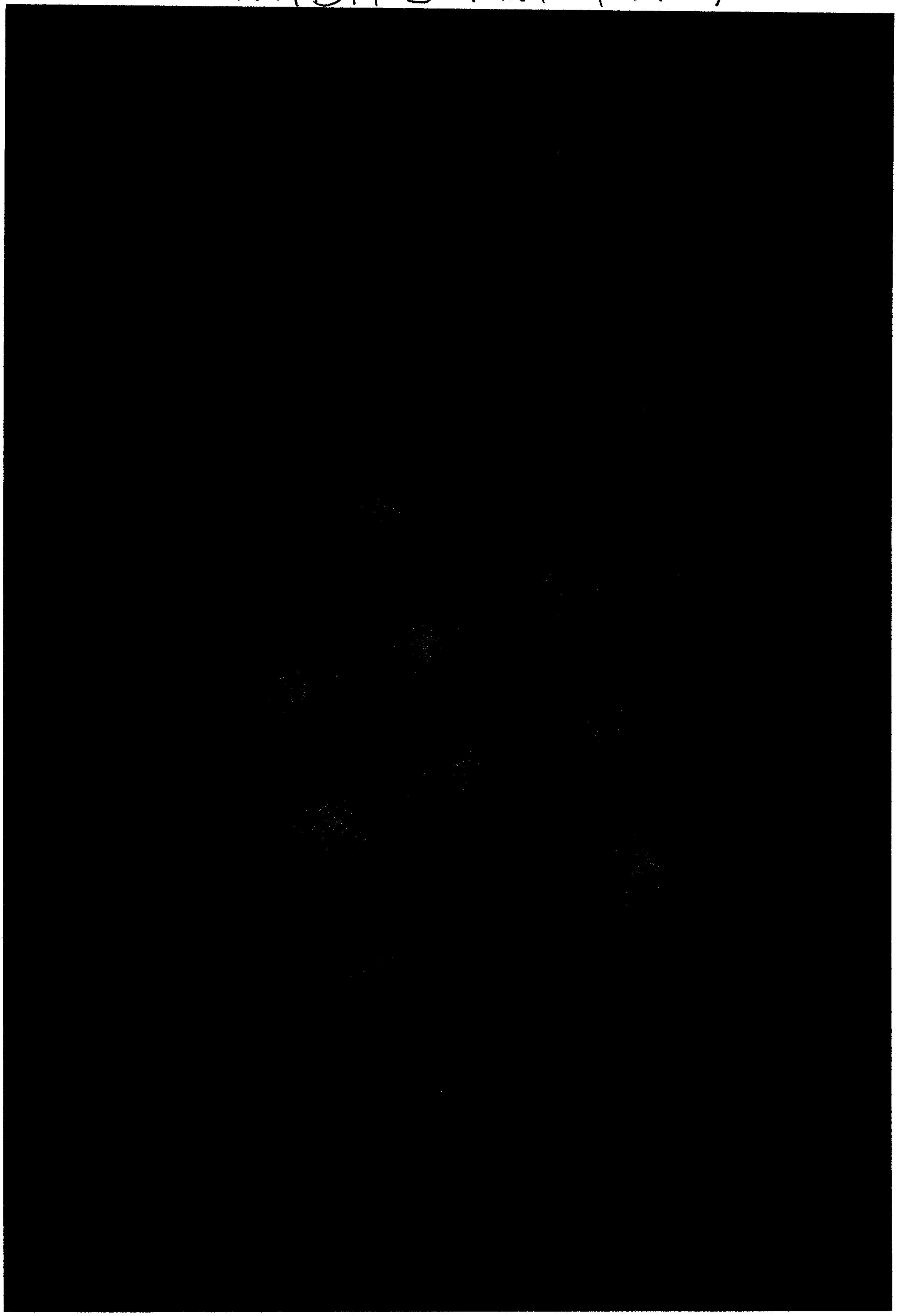

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EXHIBIT E Part 5 of 7

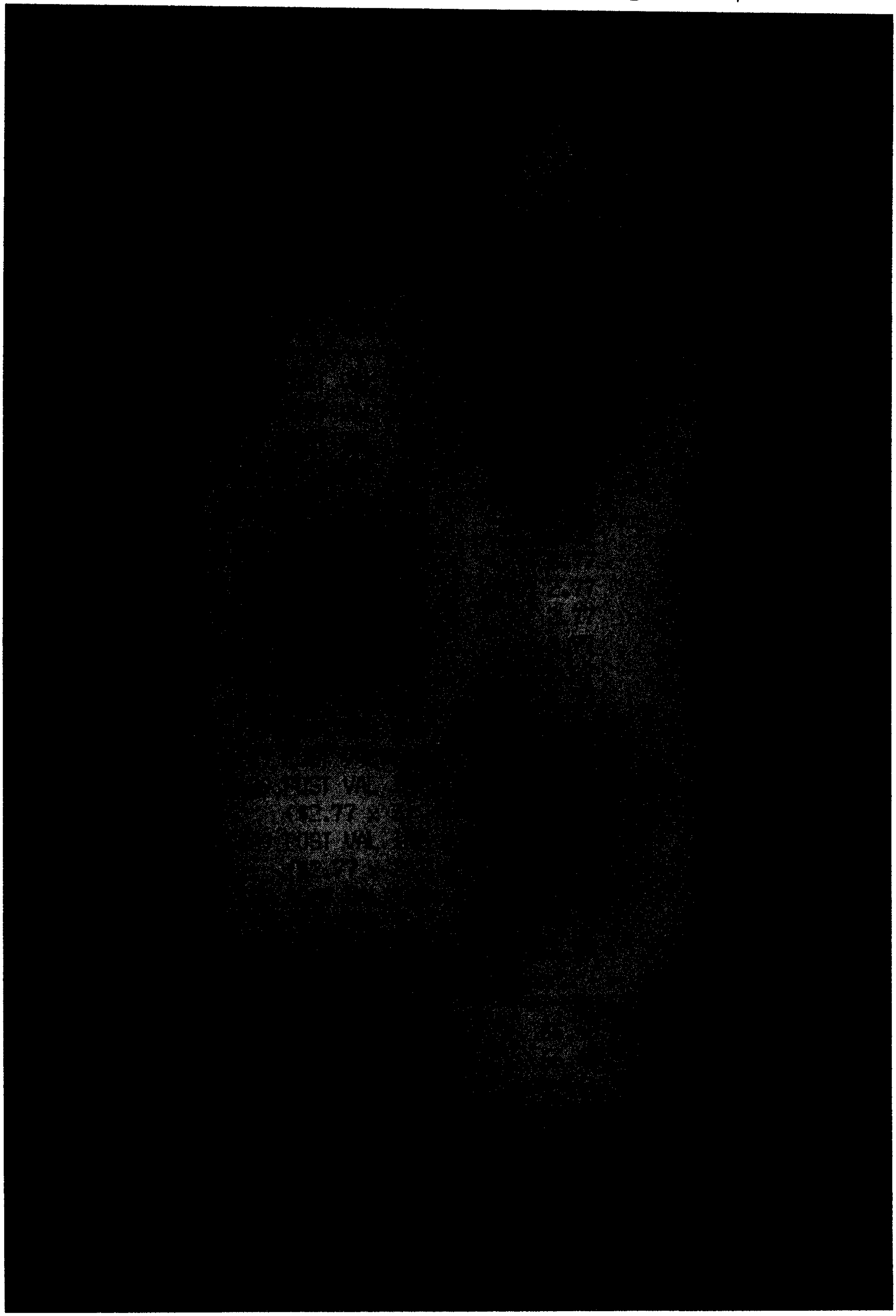

EXHIBIT E, PART 6 of 7

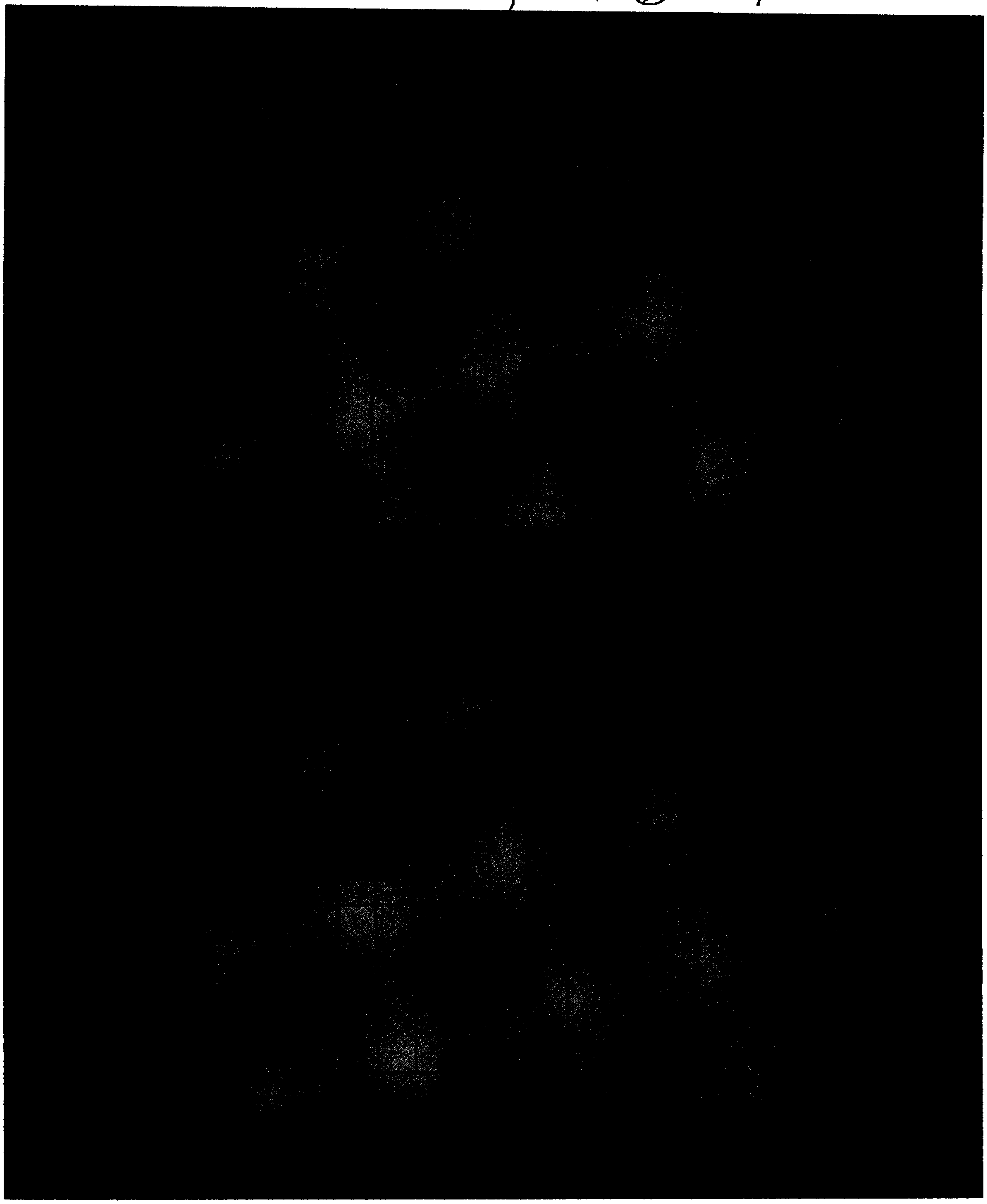

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EXHIBIT E PART, 7 of 7

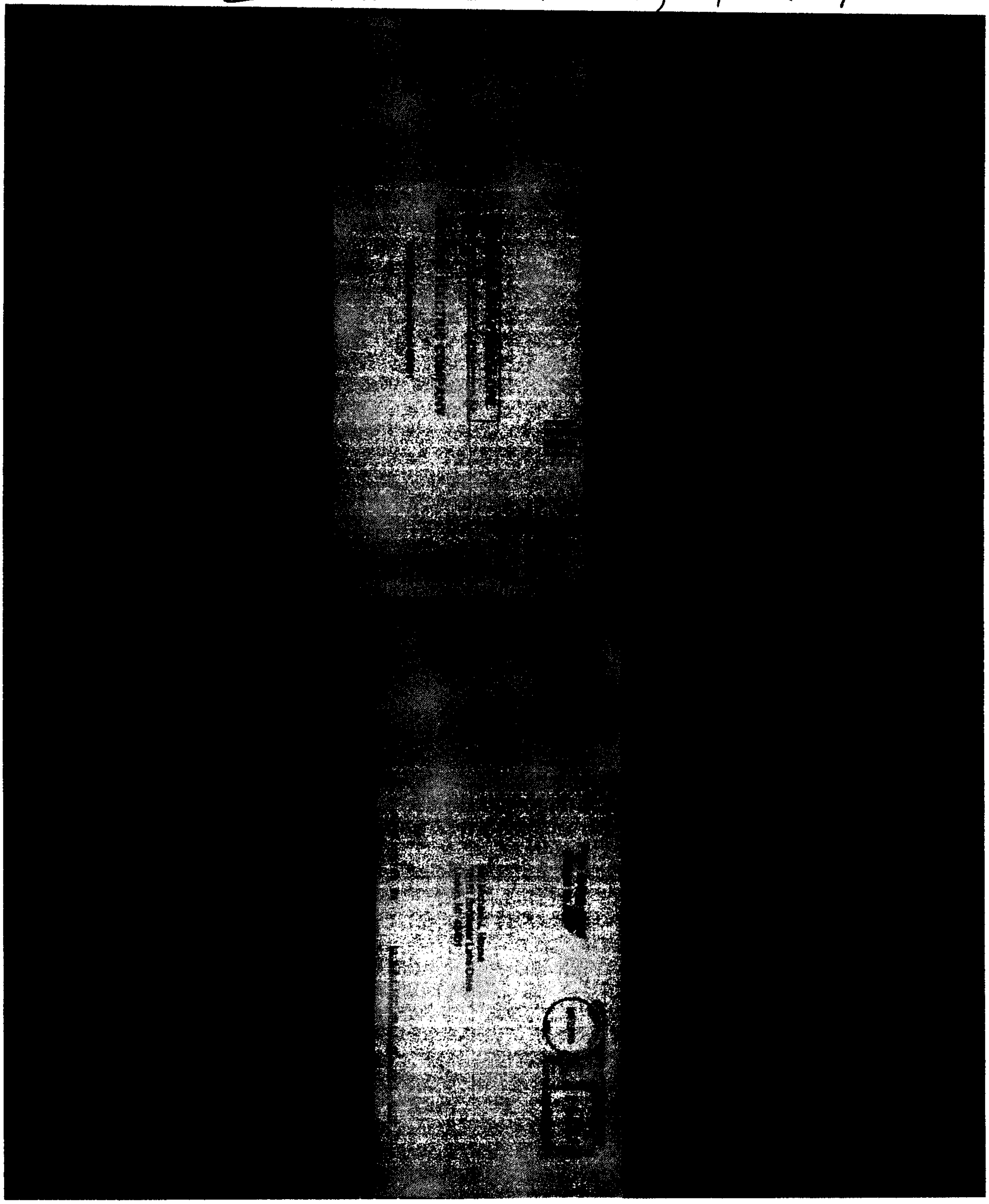

EXHIBIT F, Part 1 of 3

FIA18 (HTTPS://WWW.GE.COM/REPORTS/TAG/FIA18/)

Out Of This World: GE Aviation Engineer Ted Ingling Started Out As Car Mechanic. Now He Is Leading The Program Developing The World's Largest Jet Engine

Jul 16, 2018 by Tomas Kellner (https://www.ge.com/reports/author/200020778/)

When Ted Ingling was growing up in a small town in Michigan, he wanted to be a car mechanic. But the plan didn't work out, and the

EXHIBIT F Part 2 of 3

Out Of This World: GE Aviation Engineer Ted Ingling Started Out As Car Mechanic. Now He Is Leading The Program Developing The World's Largest Jet Engine - GE Reports

Jul 16, 2018 by Tomas Kellner

FIA18

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EXHIBIT F Part 3 of 3

The fan of the GE9X is more than 11 feet in diameter — 134.5 inches. But Ingling says that a 10 percent fuel improvement compared to its predecessors is "really the hallmark of the engine." Image credit: GE Aviation.

GER: Do you use 3D printing just to manufacture parts?

TI: No. It also helps us during the design phase. For example, designing the combustion system for a jet engine the traditional way can take 18 months, and you have to spend money on tooling to cast the prototypes. Imagine trying to iterate, learn something new, refine your design, test it and iterate again if it takes months just to build your tooling. We found, quite frankly, that additive manufacturing is quite powerful, especially in the early phases of development, where it allows the design team to iterate on concepts much faster.

GER: Is the GE9X using any technology that's not inside the GE90?

TI: Yes, we are using parts made from a light and heat-resistant material called ceramic matrix composite. This material is very different from the carbon-fiber composite we use for the fan blades. It's one-third the weight of steel, but it also can withstand temperatures where most metal superalloys grow soft. It took us 30 years to develop the technology at GE Global Research, our corporate labs, and we pioneered it inside the LEAP, a jet engine built by CFM International, a 50/50 joint venture between GE Aviation and Safran Aircraft Engines. The LEAP is the best-selling engine in CFM's history, with orders topping $220 billion. Because of that program, we now know how to mass-produce parts from the material and design new parts that take advantage of its properties.

GER: Why does the material matter?

TI: Remember when I told you about how we're the chasing bigger bypass ratios to make our engines more efficient? The ceramics allow us to do that by making the core of the engine smaller.

GER: Rather than making the fan bigger?

TI: Yes. We want the bypass ratio as big as possible, and we can do that by shrinking the physical size of the core and still producing the necessary power to drive the fan. We do this by increasing the pressure ratio inside the core, which allows us to get more energy from a smaller volume. As a result, we get a larger natural bypass without having to take on the drag and the weight from growing the fan bigger. Essentially, we shrink the core and make the engine a little smaller on the inside so the fan doesn't have to be as big.

GER: This is brilliant, but this miniaturization of the core must involve some extreme engineering.

TI: Right, this is where the ceramic matrix composites come in. Squeezing the pressures inside the core also raises the temperature. The ceramics can handle as much as 2,400 degrees Fahrenheit and allow us to increase the temperature. We can turn this increase in temperature into extra performance.

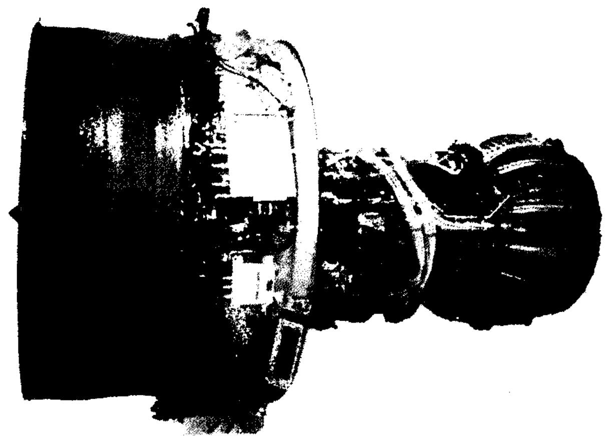
EXAHIBIT G, Part 1 of 7

WIKIPEDIA

General Electric GEnx

The **General Electric GEnx** ("General Electric Next-generation") is an advanced dual rotor, axial flow, high-bypass turbofan jet engine in production by GE Aviation for the Boeing 787 and 747-8. The GEnx is intended to replace the CF6 in GE's product line.

GEnx



General Electric GEnx at the Paris Air Show 2009

Type	Turbofan
Manufacturer	GE Aviation
First run	2006
Major applications	Boeing 747-8 Boeing 787 Dreamliner
Unit cost	787-8 GEnx-1B: $25.6 million[1] 787-9 GEnx-1B: $28.7 million[2] 747-8 GEnx-2B: $22.5 million[3]
Developed from	General Electric GE90
Developed into	CFM LEAP

Contents

Development

The GEnx and the Rolls-Royce Trent 1000 were selected by Boeing following a run-off between the three big engine manufacturers. The GEnx uses some technology from the GE90 turbofan,[4] including composite fan blades, and the smaller core featured in earlier variants of the engine. The engine carries composite technology[5] into the fan case.

Boeing wanted to allow changing between alternative 787 engines within 24 hours, but had not worked it out by 2007.[6] The engine market for the 787 is estimated at US$40 billion over the next 25 years. A first is the elimination of bleed air systems using high temperature/high pressure air from the propulsion engines to power aircraft systems such as the starting, air-conditioning and anti-ice systems. Both engines enable the move towards the *More Electric Aircraft*, that is, the concept of replacing previously hydraulic and pneumatic systems with electrical ones to reduce weight, increase efficiency, and reduce maintenance requirements.

The GEnx was expected to produce thrust from 53,000 to 75,000 lbf (240 to 330 kN) with first tests commencing in 2006 and service entry by 2008 (delayed by 787 deliveries). Boeing predicts reduced fuel consumption of up to 20% and significantly quieter engines than current turbofans. A 66,500 lbf (296 kN) thrust version (GEnx-2B67)

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EXHIBIT G Part 2 of 7

will be used on the 747-8. Unlike the initial version, for the 787, this version has a traditional bleed air system to power internal pneumatic and ventilation systems. It will also have a smaller overall diameter than the initial model to accommodate installation on the 747.

GEnx on 747-8I prototype

General Electric began initial test runs of the bleedless GEnx variant on 19 March 2006.[7] The first flight with one of these engines took place on 22 February 2007, using a Boeing 747-100, fitted with one GEnx engine in the number 2 (inboard left hand side) position.

Operational history

Introduced in late 2011 on a 747-8 freighter, Cargolux surpassed one million flight hours in early 2017.[8] In the summer of 2012, three engines suffered Low Pressure Turbine (LPT) failures. One failure was caused by an assembly problem, which led to inspections of all other engines then in service.[9]

During the spring and summer of 2013, GE learned of four 747-8F freighters that suffered icing in their engines at altitudes of 40,000 feet and above. The most serious incident involved an AirBridgeCargo freighter; on July 31, while at an altitude of 41,000 feet over China, the flight crew noted two engines surging while a third lost substantial power. The pilots were able to land the plane safely but the engines were found to have sustained damage. Among the possible factors cited was "'unique convective weather systems' such as unusually large thunderstorms reaching high altitudes." Boeing is working with GE on software solutions to the problem.[10] Altitude was restricted until GE changed the software to detect the high-altitude ice crystals and open bleed air valve doors to eject them before they enter the core.[8]

In March 2014, a GEnx-powered Boeing 787 had its first in-flight shut down in operation when a JAL flight had to divert to Honolulu after an oil pressure alert, bringing its in-flight shut down rate to 1 per 278,000 hours.[11] In January 2016 a Japan Airlines 787 had an inflight shutdown after flying through icing conditions, caused by ice formed on fan blades and ingested: the blades moved forward slightly and rubbed on the abradable seal in the casing.[8] In March 2016, the US FAA ordered emergency fixes on the GEnx-1B PIP2.[12] The airworthiness directive affects 43 Boeing 787 Dreamliners in the US.[13] Abradable material in the casing in front of the fan blades was ground to keep them from rubbing when ingesting ice or debris on 330 GEnx PIP-2.[8]

In early 2018, of 1277 orders for the B787, 681 selected the GEnx (53.3%), 420 the Rolls-Royce Trent 1000 (32.9%) and 176 were undecided (13.8%).[14]

Design

The GEnx is derived from the GE90 with a fan diameter of 111.1 in (282 cm) for the 787 and 104.7 in (266 cm) for the 747-8. To reduce weight, it features 18 composite fan blades, a composite fan case and titanium aluminide stage 6 and 7 low-pressure turbine blades. Fuel efficiency is improved by 15% compared to the CF6, the bypass ratio reaches up to 9.0:1 and the overall pressure ratio up to 58.1:1. It has a 10 stage high-pressure compressor and is quieter, helped by larger, more efficient fan blades.[15]

It stays on wing 20% longer, uses 30% fewer parts to lower maintenance costs and has a contra-rotating architecture.[16] The Lean TAPS combustor reduces NOx gases with required pressure loss and backflow

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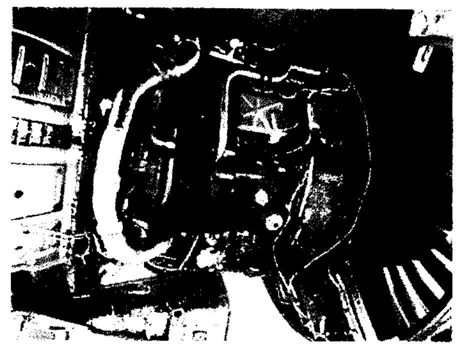
margin.[17]

Fan blades have steel alloy leading edges and the composite fan case reduces thermal expansion. To reduce fuel burn, the 23:1 pressure ratio high-pressure compressor is based on the GE90-94B, shrouded guide vanes reduce secondary flows and counter-rotating spools for the reaction turbines reduce load on guide vanes.[18]

Fan blades and inlet guide vanes of GEnx-2B

To reduce maintenance cost and increase engine life, spools with lower parts count are achieved by using blisks in some stages, low blade counts in other stages and by using fewer stages; internal engine temperatures are reduced due to more efficient cooling techniques and debris extraction within the low-pressure compressor protects the high-pressure compressor.



Detail of GEnx core

Applications

- Boeing 747-8
- Boeing 787 Dreamliner

Variants

Variants were certified by the EASA[19]

Designation	EASA certification date
GEnx-1B	29 March 2011
GEnx-2B67	29 March 2011
GEnx-2B67B	21 October 2011
GEnx-1B/P1	3 July 2012
GEnx-1B/P2	24 June 2013
GEnx-2B67/P	24 January 2014
GEnx-1B76/P2	17 May 2018

EXHIBIT G Part 4 of 7

GEnx-1B/2B variants[19]

Designation	Continuous	Take-off rating
GEnx-1B54/P2	250.4 kN (56,300 lbf)	255.3 kN (57,400 lbf)
GEnx-1B58/P2		271.3 kN (61,000 lbf)
GEnx-1B64/P2	273.6 kN (61,500 lbf)	298.0 kN (67,000 lbf)
GEnx-1B67/P2		308.7 kN (69,400 lbf)
GEnx-1B70/P2	295.8 kN (66,500 lbf)	321.6 kN (72,300 lbf)
GEnx-1B70/72/P2		
GEnx-1B70/75/P2		
GEnx-1B74/75/P2	305.2 kN (68,600 lbf)	341.2 kN (76,700 lbf)
GEnx-1B76/P2		349.2 kN (78,500 lbf)
GEnx-1B76A/P2		
GEnx-1B78/P2		357.6 kN (80,400 lbf)
GEnx-1B75/P2	306.0 kN (68,800 lbf)	345.2 kN (77,600 lbf)
GEnx-2B67	260.2 kN (58,500 lbf)	299.8 kN (67,400 lbf)
GEnx-2B67B/P2		
GEnx-2B67/P		

Specifications

Rear view of a GEnx-1B on a Jetstar 787-8, showing noise-reducing chevrons

EXHIBIT G, Part 5 of 7

Data sheet[20]

Variant	-1B70	-1B74/75	-1B76	-2B67B
Application	787-8	787-9	787-10	747-8
Fan Diameter	111.1 in (282 cm)			104.7 in (266 cm)
Compressor	1 Fan 4 LP 10 HP			1 Fan 3 LP 10 HP
Turbine	2 HP 7 LP			2 HP 6 LP
Takeoff thrust	69,800 lbf (310 kN)	74,100 lbf (330 kN)	76,100 lbf (339 kN)	66,500 lbf (296 kN)
Takeoff Bypass ratio	9.0	8.8	8.8	8.0
Top-of-climb OPR	53.3	55.4	58.1	52.4
Takeoff air per sec.	2,559 lb (1,161 kg)	2,624 lb (1,190 kg)	2,658 lb (1,206 kg)	2,297 lb (1,042 kg)
Flange to flange	184.7 in (469 cm)			169.7 in (431 cm)
Nominal RPM[21]	LP 2,560, HP 11,377			LP 2,835, HP 11,377
Dry weight[21]	13,552 lb (6,147 kg)			12,397 lb (5,623 kg)
Thrust/weight	5.15	5.47	5.62	5.36

See also

Related development

- General Electric GE90
- General Electric GE9X

Comparable engines

- Engine Alliance GP7000
- Rolls-Royce Trent 1000

Related lists

- List of aircraft engines

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External links

- Official website (https://www.geaviation.com/commercial/engines/genx-engine)
- "General Electric's GEnx-1B engine for the Boeing 787 makes first flight on 747 testbed" (http://www.flightglobal.com/news/articles/picture-general-electrics-genx-1b-engine-for-the-boeing-787-makes-first-flight-on-747-212278). *Flight International.* 23 Feb 2007.
- "GE plans mid-July nod for GEnx siblings" (https://www.flightglobal.com/news/articles/ge-plans-mid-july-nod-for-genx-siblings-343337/). *Flight International.* 16 June 2010.

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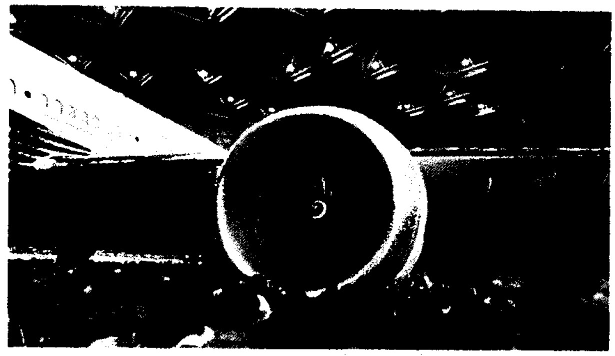
WIKIPEDIA EXHIBIT H, Part 1 of 7

General Electric GE9X

The **General Electric GE9X** is a high-bypass turbofan under development by GE Aviation for the Boeing 777X. It first ran on ground in April 2016 and first flew on March 13, 2018; it is to power the 777-9's maiden flight in 2019 and enter service in 2020. Derived from the General Electric GE90 with a larger fan, advanced materials like CMCs, higher bypass ratio and compression ratios, it should improve fuel efficiency by 10% over its predecessor. The engine has a thrust of 105,000 lbf (470 kN).

GE9X



GE9X under the wing of the 777X during roll-out in March 2019

Type	Turbofan
Manufacturer	GE Aviation
First run	April 2016
Major applications	Boeing 777X
Program cost	Over $2 billion[1]
Unit cost	US$41.4M list price (2016)[2]
Developed from	General Electric GE90

Contents

Development

In February 2012, GE announced studies on a more efficient derivative, dubbed the GE9X, to power both the -8/9 variants of the new Boeing 777X. It was to feature the same 128 in (325 cm) fan diameter as the GE90-115B with thrust decreased by 15,800 lbf (70 kN) to a new rating of 99,500 lbf (443 kN) per engine.[3] The -8X engine was to be derated to 88,000 lbf (390 kN).[4]

In 2013, the diameter of the fan was increased by 3.5 in (9 cm) to 132 in (335 cm).[5] At the time of the 777X launch in November 2013, its design should be finalised by 2015, the first engine would be tested in 2016, flight testing should debut in 2017 and certification happen in 2018.[6] In 2014, thrust was increased from 102,000 to 105,000 lbf (450 to 470 kN) and fan diameter to 133.5 in (339 cm).[7]

EXHIBIT H, Part 2 of 7

Testing

First test engine

The first engine to test (FETT) completed its first test run in April 2016.[8] With 375 cycles and 335 test hours, validated its architecture (as a system, as opposed to a collection of modules) for aerodynamic performance, mechanical system verification and aerothermal heating validation.[9]

Cold weather test

The GE9X went through icing tests in Winter 2017.[10] The FETT was finally used for 50 cold weather test points such as ground fog or natural icing conditions, minor modifications included tweaking parts using additive manufacturing for several pivots, used within a month; icing certification and evaluation will be finished in the 2017-2018 winter at Winnipeg, Manitoba.[9]

With testing completed to simulate high-altitude conditions, the GE9X should be free of ice crystal icing (core icing) which was an issue for the GEnx but is now better understood as well as traditional rime ice. The improvements developed for the GEnx were the variable bypass valve doors: airflow is improved by the way they open inward into the flow path between the booster and high-pressure compressor, naturally ejecting the ice and sand to prevent them from entering the core.[9]

Second engine to test

Minor tweaks between FETT and second engine to test (SETT) are pivotal to hit its efficiency goals: in the throat between the HP turbine outlet into the LP turbine inlet, the turbine's pinch point is altered to set the operating line of the compressor, turbine and 134.5 in (342 cm) fan. Blades at the back end of the 11-stage HP compressor are just over 1 in (25 mm) high. The HP compressor front end tip clearance was modified as the compressor was fine-tuned since initial tests in early 2013. The SETT seems to meet flow function and operability design points. Its testing started on May 16, 2017, at Peebles, Ohio, 13 months after FETT; it is the first to be built to the finalized production standard for certification.[9] During extreme test conditions for the FAA 150 hr block test, the variable stator vane (VSV) actuator lever arms failed and their redesign led to a 3–month delay.[11] It was joined by four more test engines by May 2018.[12]

Certification campaign

The certification program began in May 2017.[10] Eight other test engines will be involved in the certification campaign, plus one for ETOPS certification configured with a Boeing nacelle. A core that will run in the Evendale, Ohio, altitude test cell for aeromechanical and vibratory testing and test engines 003, 004, and 007 are being assembled to be completed in 2017, with the fourth engine to be ground-tested in the third quarter before flying on the testbed later in the year from Victorville, California. From early 2018 eight compliance engines plus a pair of spares will be delivered for the four 777-9 flight-test aircraft.[9] Its type certification is planned for the fourth quarter of 2018.[13] By November 2017, five engines had been test run.[14]

The second engine will pass the FAA 150 h block test at its operational limits, running at triple red-line conditions: maximum fan speed, maximum core speed and maximum exhaust gas temperature. The third engine is in Peebles, Ohio, while the fifth will travel to Winnipeg for icing tests starting by end of 2017 while three other engines are

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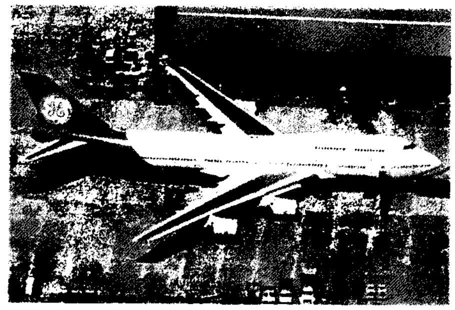
currently under assembly. The initial 777X flight-test engines will be shipped in 2018 for an initial 777-9 flight in early 2019.[15] A quarter of the certification testing was done by May 2018: icing, crosswind, inlet, fan and booster aeromechanics, HP turbine aeromechanics and thermal survey.[12]

Flight testing

As it is larger than the GE90, for testing it fits only the 747-400 with larger main gear struts and bigger tires and not the previous -100 GE testbed, and the tested engine is tilted 5° more than the original CF6.[13] Boeing builds a large, specially designed pylon for the testbed.[9] Suspended on a 19 ft (580 cm) strut, the fourth engine of the program has been mounted in November to begin flight testing at the end of 2017. The 134 in (340 cm) fan is encased in a 174 in (440 cm) nacelle, with 1.5 ft (0.46 m) of ground clearance.[15] It weighs 40,000 lb (18 t) with its custom pylon and wing strengthening, compared to 17,000 lb (7.7 t) for the CF6-80C2s and its pylon.[16]


GE Propulsion Test Platform 747-400

In February 2018, the GE9X's first flight was delayed by problems discovered in the HPC variable stator vanes (VSV) lever arms. These are to be changed for the production engine, but will not affect its flow. Also a routine A Check discovered fan-case corrosion and HP turbine airfoils limits on the 747 testbed's CF6 engines.[17] It first flew on March 13 with the previous design of the VSV external lever arm.[18] In early May, the first flight test phase of two was wrapped up after 18 flights and 110 hours: after checking the aircraft and systems, the GE9X high-altitude envelope was explored and its cruise performance evaluated, the second phase is scheduled to begin in the third quarter.[12]

By October 2018, half of the certification was completed, and eight prototypes are used, mostly in Peebles, Ohio: #1 will be stored; the blade-out will be deliberately separated from the hub of #2 at takeoff power; after crosswind ground testing, #3 will be used for cyclic and load testing of the thrust reverser cascade assembly; the airborne #4 will explore more edges of the flight envelope like low altitudes for certification flight-tests from November through March; #5 will test unbalanced endurance to check vibration levels, before ETOPS certification; #6 will pass ingestion tests later in 2018; after LP turbine over-temperature tests, #7 will endure a second icing campaign in Winnipeg, Manitoba; #8 will be prepared by mid-October for the triple redline FAA 150 h endurance test. Eight compliance engines, plus two spares, are expected from November in Everett, Washington, to be installed on the first 777-9, to complete most of its flight tests in 2019 and enter service in 2020.[11]

A second phase, of 18 flights, began on 10 December to evaluate the software and hot-and-high performance until the first quarter of 2019 before its FAA certification the same year. By then, water ingestion, overheating and crosswinds tests were completed, before blade-out, hailstone, bird ingestion and block or endurance testing. Flight tests are based in Victorville, California, and stretch to Seattle, Colorado Springs, Colorado, Fairbanks, Alaska and Yuma, Arizona.[19]

By 4 January 2019, eight test flights and 55h of run time were completed.[20] At the end of January, the case and rear turbine frame strut were damaged during the blade out test and affected components are revised. In early May, the flight test campaign was completed after 320 hours, focused on high-altitude cruise fuel burn. A compressor anomaly was detected in an engine pre-delivery test while the first engines were installed on the 777X

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prototype. The engines should be modified to a final certifiable configuration standard before the maiden flight, delayed after the previously expected June 26. The issue is mechanical and not aerodynamic, not affecting performance or engine configuration, and is at the front of the 11-stage high-pressure compressor. Before certification, final tests include a full durability block test, replacing the usual "triple redline" test at maximum temperatures, pressures and speeds, as modern high-bypass ratio engines cannot achieve all maximum conditions near sea level.[21]

Design

The GE9X should increase fuel efficiency by 10% over the GE90.[3] Its 61:1 overall pressure ratio should help provide a 5% lower thrust specific fuel consumption (TSFC) than the XWB-97 with maintenance costs comparable to the GE90-115B.[6] The initial thrust of 105,000 lbf (470 kN) will be followed by 102,000 and 93,000 lbf (450 and 410 kN) derated variants.[12] GE invested more than $2 billion for its development. Its nacelle is 184 in (4,700 mm) wide.[1]

Most efficiency increase comes from the better propulsion efficiency of the higher-bypass-ratio fan.[11] The bypass ratio is planned for 10:1.[4] The fan diameter is 134 in (340 cm).[22] It has only 16 blades, whereas the GE90 has 22 and the GEnx has 18. This makes the engine lighter, and allows the low pressure (LP) fan and booster to spin faster to better match its speed with the LP turbine. The fan blades feature steel leading edges and glass-fibre trailing edges to better absorb bird impacts with more flexibility than carbon fiber.[2] Fourth generation carbon fiber composite materials, comprising the bulk of the fan blades, make them lighter, thinner, stronger, and more efficient.[23] Using a composite fan case will also reduce weight.[24]

The high pressure (HP) compressor is up to 2% more efficient.[11] As the 129.5 in (329 cm) GE90 fan left little room to improve the bypass ratio, GE looked for additional efficiency by upping the overall pressure ratio from 40 to 60, focusing on boosting the high-pressure core's ratio from 19:1 to 27:1 by using 11 compressor stages instead of 9 or 10, and a third-generation, twin-annular pre-swirl (TAPS) combustor instead of the previous dual annular combustor. Able to endure hotter temperatures, ceramic matrix composites (CMC) are used in two combustor liners, two nozzles, and the shroud up from the CFM International LEAP stage 2 turbine shroud. CMCs are not used for the first-stage turbine blades, which have to endure extreme heat and centrifugal forces. These are improvements planned for the next iteration of engine technology.[25]

The first-stage HP turbine shroud, the first- and second-stage HP turbine nozzles and the inner and outer combustor linings are made from CMCs, only static components, operating 500 °F (260 °C) hotter than nickel alloys with some cooling.[11] CMCs have twice the strength and one-third the weight of metal. The compressor is designed with 3D aerodynamics and its first five stages are blisks, combined bladed-disk. The combustor is lean burning for greater efficiency and 30% NOx margin to CAEP/8. The compressor and high pressure turbine are made from powdered metal. The low-pressure turbine airfoils made of titanium aluminide (TiAl) are stronger, lighter, and more durable than nickel-based parts.[22] 3D printing is used to manufacture parts that would otherwise be impossible to make using traditional manufacturing processes.[23] CMCs need 20% less cooling.[6]

Specifications

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GE Aviation GE9X[22]

Variant	105B1A
Application	777-9/777-8 (future)
Type	Dual rotor, axial flow, high bypass turbofan
Compressor	1 fan, 3-stage LP, 11-stage HP
Turbine	2-stage HP, 6-stage LP
Fan diameter	134 in (340 cm)
Takeoff thrust	105,000 lbf (470 kN)
Bypass ratio	10:1
Pressure ratio	60:1
Weight	40,000 lb (18 t), complete with test pylon[16]

See also

Related development

- General Electric GE90
- General Electric GEnx

Comparable engines

- Rolls-Royce Trent XWB
- Rolls-Royce Advance (Future)

Related lists

- List of aircraft engines

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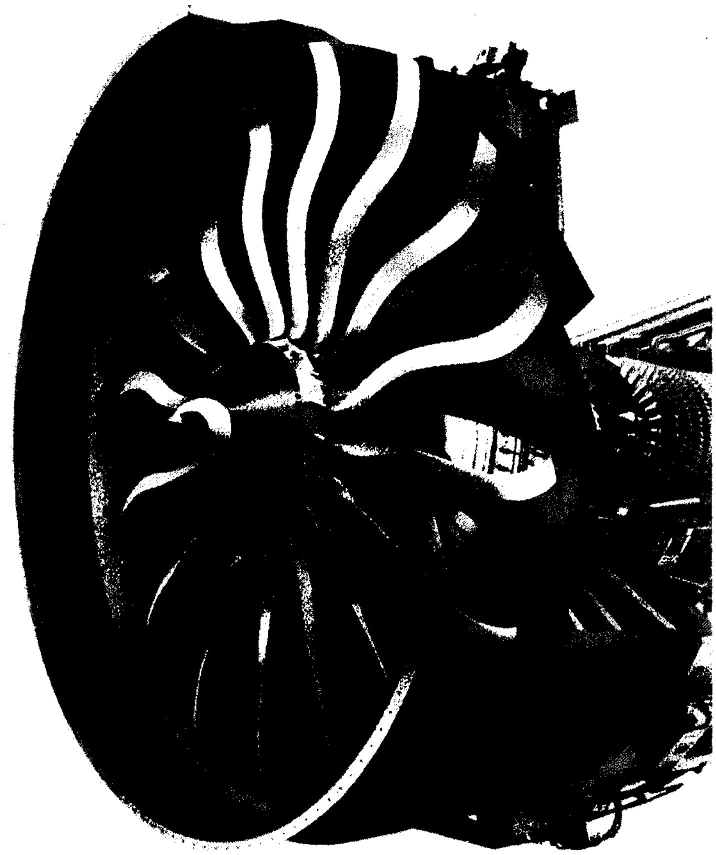
With the most extensive techr
GE Aviation, the GE9X engine \
A blend of evolutionary and re'
the most fuel-efficient jet engi

First engine tested
March 2016



10% lower specific fuel consumption (SFC) than the GE90-115B

5% better SFC than any other twin-aisle engine in service in 2020

27:1 compressor pressure ratio
The highest ever in commercial aviation

EXHIBIT I, Part 1 of 2

GRC (HTTPS://WWW.GE.COM/REPORTS/TAG/GRC/)

Ceramic Matrix Composites (CMC) Allow GE Jet Engines to Fly Longer

CMC Developed so Engines can operate at Higher temperatures for Better Combustion

Feb 9, 2015 by Tomas Kellner (https://www.ge.com/reports/author/groupsjr/)

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